

## Ozone Source Apportionment Techniques in CAMx

The Ozone Source Apportionment Technique (OSAT) and the companion Anthropogenic Precursor Culpability Assessment (APCA) technique were developed by Rambol Environ, as described in detail in section 7.1 of the CAMx version 6.40 User's Guide (Ramboll Environ, December 2016). The text in italics below provides an overview of these techniques, based on information in the User's Guide.

*Yarwood et.al., developed an ozone source attribution approach that has become known as the "Ozone Source Apportionment Technology" (OSAT). The current version of OSAT (OSAT3) includes an improved approach to handle NO<sub>x</sub> recycling (Yarwood and Koo, 2015). OSAT3 improves the accuracy of the OSAT methods by keeping track of the source(s) of ozone removed by reaction with NO to form NO<sub>2</sub> and subsequently returned as ozone when NO<sub>2</sub> is destroyed by photolysis. The OSAT3 update tends to allocate more ozone to long-range transport (due to contributions from NO<sub>x</sub> during downwind transport) and less to local production.*

*In general, the ozone formation process is controlled by the relative availability of NO<sub>x</sub> and VOC, and so ozone formation is described either as NO<sub>x</sub>-limited or VOC-limited, respectively. When ozone production at a given location and time is NO<sub>x</sub>-limited, it makes sense to attribute that production to source region/groups based on their contributions to the local NO<sub>x</sub>, and similarly to attribute production based on VOC contributions when ozone formation is VOC-limited.*

*The Anthropogenic Precursor Culpability Assessment (APCA) contains the same scientific basis in OSAT, except that APCA accounts for the fact that certain emission categories are not controllable (e.g., biogenic emissions) and that apportioning ozone production to these categories does not provide information that is relevant to development of control strategies. To address this, in situations where OSAT would attribute ozone production to non-controllable emissions, APCA re-allocates that ozone production to the controllable precursors that participated in ozone formation with the non-controllable precursor. For example, when ozone formation is due to biogenic VOC and anthropogenic NO<sub>x</sub> under VOC-limited conditions (a situation where OSAT would attribute ozone production to biogenic VOC), APCA attributes ozone production to the anthropogenic NO<sub>x</sub> present. The only difference between APCA and OSAT is the algorithm used to allocate ozone production under VOC or NO<sub>x</sub>-limited conditions. The OSAT3 update does not revise the allocation of ozone production under VOC or NO<sub>x</sub>-limited conditions and therefore the APCA algorithm works with the OSAT3 update. Using APCA instead of OSAT results in more ozone formation attributed to anthropogenic NO<sub>x</sub> sources and less ozone formation attributed to biogenic VOC sources.*

The EPA believes that the APCA tool is the most appropriate source apportionment technique for quantifying contributions for the purposes of assessing ozone transport for regulatory purposes because it captures the total ozone formed from anthropogenic emissions in a state and it is constructed to provide source culpability data to inform the design of emissions control strategies.